



NIOSH
Fire Fighter Fatality Investigation
and Prevention Program

Death in the line of duty...

A Summary of a NIOSH fire fighter fatality investigation

May 24, 1999

Fire Fighter Dies After Returning From a Call Involving Smoke in an Apartment Building- Massachusetts

SUMMARY

On January 29, 1999, a 64-year-old male fire fighter responded to a call involving smoke in an apartment building. At the scene the victim did not report symptoms of chest pain, nor was he in acute distress. After approximately 10 minutes on scene, the District Chief and the victim returned to the fire station in the Chief's vehicle. Upon starting to back the vehicle into the station, the victim slumped against the driver's-side door. The Chief, noting the victim's condition, attempted to shift the vehicle into park. However, the vehicle lurched backward and struck a parked fire apparatus (Engine 42). The Chief then shifted the vehicle's transmission into park, got out of the vehicle, and got help from crew members at the station. The victim was noted to be unresponsive in the passenger seat. Cardiopulmonary resuscitation (CPR) was begun as an engine company and an ambulance were requested for a suspected cardiac arrest. Upon arrival, paramedics with the ambulance service provided CPR and advanced life support (ALS) onscene for a total of 20 minutes before embarking to the hospital. ALS and CPR were continued enroute to the hospital and in the hospital's emergency department (ED). In the ED, the patient was found to be in cardiogenic shock. After approximately 10 minutes in the ED, and treatment in the cardiac catheterization lab, the victim was pronounced dead, and resuscitation measures were discontinued. The death certificate, completed by the State medical examiner, listed "coronary sclerotic heart disease" as the immediate cause of death. The autopsy report, also completed by the State medical examiner, listed the final diagnosis as "occlusive coronary artery disease."

Other agencies have proposed a three-pronged strategy for reducing the risk of on-duty heart attacks

and cardiac arrests among fire fighters. This strategy consists of (1) minimizing physical stress on fire fighters, (2) screening to identify and subsequently rehabilitate high risk individuals, and (3) encouraging increased individual physical capacity. Issues relevant to this fire department include the following:

- ***Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.***
- ***Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.***

INTRODUCTION & METHODS

On January 29, 1999, a 64-year-old male fire fighter lost consciousness when he returned to the fire station after responding to a call of smoke in an apartment building. Despite CPR and ALS administered by EMTs of his company, ambulance EMTs, ambulance

The **Fire Fighter Fatality Investigation and Prevention Program** is conducted by the National Institute for Occupational Safety and Health (NIOSH). The purpose of the program is to determine factors that cause or contribute to fire fighter deaths suffered in the line of duty. Identification of causal and contributing factors enable researchers and safety specialists to develop strategies for preventing future similar incidents. To request additional copies of this report (specify the case number shown in the shield above), other fatality investigation reports, or further information, visit the Program Website at:

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paramedics, emergency department personnel, and emergency cardiac catheterization, the victim died. NIOSH was notified of this fatality on February 1, 1999, by the United States Fire Administration. On February 8, 1999, NIOSH contacted the affected Fire Department to initiate the investigation. On April 14, 1999, a Safety and Occupational Health Specialist and a Senior Medical Epidemiologist from the NIOSH Fire Fighter Fatality Investigation Team and a NIOSH Industrial Hygienist traveled to Massachusetts to conduct an onsite investigation of the incident.

During the investigation NIOSH personnel met with and interviewed the following:

- The Commissioner of the Fire Department (FD)
- Deputy Fire Chief of Operations
- Fire Department Medical Director
- The Local President of the International Association of Fire Fighters (IAFF)
- District Fire Chief involved in this incident

During the site visit NIOSH personnel also reviewed the following:

- Existing Fire Department investigative records, including the board of inquiry report, incident reports, co-worker statements, and dispatch records
- The victim's personnel and medical file maintained at the Fire Department
- Emergency medical services ambulance report
- The hospital's records of the resuscitation effort

- Autopsy results and death certificate of the deceased
- Past medical records of the deceased
- Fire Department policies and operating procedures
- Fire Department training records
- The Fire Department annual report for 1998

NIOSH personnel also undertook the following:

- Visited the area where the structural call occurred and the station where the victim collapsed
- Contacted the family by telephone

INVESTIGATIVE RESULTS

Incident Response. On January 29, 1999, at 1631 hours, Engine 42, Engine 52, Engine 14, Ladder 29, Ladder 4, Rescue 2, and District Chief 9 were dispatched on a single alarm to an apartment building with smoke reported on the second floor. The building was located approximately 1 mile from the Engine 42 fire station. The victim, an Aide to District Chief 9, drove the District Chief to the fire scene.

The victim and the District Chief arrived at the fire scene with other responding units at 1638 hours. Engine 52 crew members pulled 200 feet of 1¾-inch fire hose to the front door of the involved apartment and began investigating the origin of the smoke. Rescue 2 crew members assisted Ladder 29 with ventilation efforts. A pot of burning food was found on the stove. Ladder 29 crew members removed the pot from the stove, checked for fire extension, and ventilated the apartment. At 1639 hours, the Incident Commander (IC) cleared the fire



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scene and companies began to return to quarters. The victim, knowing there was no longer an active fire or source of smoke, donned bunker gear without self-contained breathing apparatus (SCBA) and entered the building to gather information for the fire incident report. After climbing the stairs to the second floor, he entered the involved apartment. After obtaining the necessary information, the victim descended the stairs to report the situation to the District Chief who was the IC at this response. All remaining units on scene departed for their respective quarters at 1644 hours.

While driving the District Chief to quarters, the victim reported no symptoms such as chest pain, shortness of breath, or palpitations. At quarters, the victim was backing the vehicle into the engine bay when the Chief noted that the victim took a deep gasp and then slumped toward the driver's door. The Chief attempted to shift the vehicle into park, but the victim's foot depressed the vehicle's accelerator and the rear of the car struck the front bumper of Engine 42. The Chief then successfully shifted the vehicle into park and summoned assistance.

At 1650 hours, Central Dispatch was notified that a fire fighter had a syncopal (fainting) episode and a basic life support (BLS) ambulance with two EMTs was dispatched at 1651 hours. Fire fighters at the fire station, trained as EMTs, removed the fire fighter from the vehicle and found him to be unresponsive, without a pulse and respirations. Cardiopulmonary resuscitation (CPR) was initiated (chest compressions and assisted ventilation with a bag valve mask) as he was placed onto a backboard, while at 1653 hours other fire fighters notified dispatch that the victim was unresponsive and requested advanced life support (ALS) assistance. All fire apparatus is equipped with automated external defibrillators (AED), and fire department EMTs placed the AED electrodes on the victim's chest. A shockable heart rhythm was reported, and a shock was delivered. The AED

reported another shockable rhythm, and the second shock was delivered as the BLS ambulance arrived at 1655 hours. The ALS ambulance was dispatched at 1655 hours.

Reassessment found the victim to be unresponsive, without a pulse or respirations. The next AED analysis did not advise a shock, and the victim was moved into the ambulance as the paramedics arrived on scene (approximately 1702 hours). CPR was continued as paramedics intubated the victim, established intravenous (IV) access, administered IV medications, and delivered shocks consistent with ALS protocols. CPR and ALS procedures were performed for a total of 30 minutes on scene and for 13 minutes during transport to the hospital.

Upon arrival in the emergency department, the victim had regained a heart rhythm (accelerated idio-ventricular rhythm [AIVR] with episodes of ventricular tachycardia), but this rhythm was unable to sustain his blood pressure. Medications (pressors) were used to raise his blood pressure for treatment of cardiogenic shock, presumably due to a myocardial infarction (MI), otherwise known as a heart attack. The victim was taken to the cardiac catheterization laboratory to palliate end-stage cardiogenic shock and to possibly treat a thrombotic (blood clot) in his coronary artery.

Medical Findings. The death certificate was completed by the State medical examiner, who listed "occlusive coronary artery disease" as the immediate cause of death. Medical records indicated that the victim had only three known risk factors (advancing age, male gender, and smoking) for coronary artery disease (CAD). The family reported he maintained a fair amount of aerobic activity off the job without chest pain.



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Pertinent findings from the autopsy, performed by the medical examiner on January 30, 1999, are listed below:

1. Atherosclerotic coronary artery disease:

Severe (90-95%) narrowing of the right coronary artery

Severe (80-85%) narrowing of the left anterior descending coronary artery

Moderate (60%) narrowing of the left circumflex artery

Scarring of the posterior left ventricle (suggestive of a previous [old] MI)

No evidence of a thrombus formation in any of the coronary arteries

2. Mild cardiomegaly

3. Severe pulmonary edema consistent with cardiogenic shock

4. Severe systemic atherosclerosis:

Aorta

Abdominal aneurysm (4.5 centimeters in diameter)

5. No evidence of significant valvular or electrical heart problems

6. Negative blood screen for alcohol or drugs

DESCRIPTION OF THE FIRE

DEPARTMENT

At the time of the NIOSH investigation, the fire department was comprised of 1,591 uniformed personnel and served a population of 570,000 residents and a daily workforce population of 1.2 million in a geographic area of 45 square miles. The housing density is 12,600 persons per square mile. There are 34 fire stations where fire fighters work the following tour of duty: Day 1, 0800-1800; Day 2, 1800-0800; Day 3, off duty; Day 4, 0800-1800; Day 5, 1800-0800; Days 6, 7, and 8, off duty. There are 4 work groups. Each shift of an engine company is staffed with an officer and three fire fighters; each ladder company, an officer and four fire fighters. The emergency medical service is also a city resource but separate from the fire department.

In 1998 the department responded to 71,961 total calls: 28,684 rescue/emergency medical services (EMS) calls, 15,344 service calls, 10,731 good intent calls, 9,951 false alarms, 4,874 fires or explosions, 2,288 hazardous conditions, 15 overpressure/ruptures, 9 natural disaster incidents, and 65 other situations.

The day of the incident, the victim began his shift at 0800. The morning was spent checking out the Chief's car and the equipment inside. Afterward, he and the Chief drove to other fire stations to pick up reports. Later in the day they performed some permit inspections. While performing this work, the victim did not report or show signs of discomfort, pain, or distress. This incident described was the victim's first emergency response during his shift.

Training. The fire department provides all new fire fighters with the basic 13-week recruit training conducted at the city's Drill School to become certified to the NFPA Fire Fighter I and II levels. All are certified First Responders and are defibrillator certified. All new fire fighters must become EMT-

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Basic certified within 1 year of employment. The department also requires annual completion of the Back-to-Basics training program and SCBA maze training. The victim had 35 years of fire fighting experience and was a certified fire fighter.

Pre-employment/Pre-placement Evaluations. The department requires a pre-employment/pre-placement medical evaluation for all new hires, regardless of age. This evaluation includes these components for all applicants:

- A complete medical history
- Height, weight, and vital signs
- Physical examination
- Vision test
- Hearing test
- Complete blood count (CBC)
- Blood lipid profile (total cholesterol, HDL cholesterol, triglycerides)
- Blood chemistries (SMA 12)
- Urinalysis
- Urine and hair drug test
- X-rays (chest, knees, spine)
- Pulmonary function tests (lung tests)
- Exercise electrocardiogram (stress or treadmill test)
- PPD tests (skin test for tuberculosis)

These evaluations are performed by a contractor hired by the Fire Department with results distributed to the fire department physician. Once this evaluation is complete, a decision regarding medical clearance for fire fighting duties is made. New hires are also required to complete a physical capacity test. This is a timed performance evaluation of typical fire fighting duties. Finally, all fire fighters are required to pass a self-contained breathing apparatus (SCBA) performance test (e.g., using an SCBA in a maze). Medical clearance for SCBA use prior to this test is not required.

Periodic Evaluations

This department does not require annual/periodic medical evaluations. If an employee is injured at work, he/she must be cleared for "return to work." This clearance must go through the fire department physician. This department does not require annual/periodic physical capacity tests. Although some stations have exercise (strength and aerobic) equipment, typically purchased by the fire fighters themselves, no voluntary or required fitness/wellness program exists. SCBA performance tests are conducted on an annual basis although no specific medical clearance for SCBA use is required.

DISCUSSION

In the United States, coronary artery disease (atherosclerosis) is the most common risk factor for cardiac arrest and sudden cardiac death¹. Risk factors for its development include increasing age, male gender, family history of coronary artery disease, smoking, high blood pressure, high blood cholesterol, obesity, physical inactivity, and diabetes². The victim had only three of these risk factors (advancing age, male gender, and smoking), yet on autopsy, he had moderate to severe atherosclerotic disease in his coronary arteries and aorta.

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The narrowing of the coronary arteries by atherosclerotic plaques occurs over many years, typically decades³. However, the growth of these plaques probably occurs in a nonlinear, often abrupt fashion⁴.

Heart attacks typically occur with the sudden development of complete blockage (occlusion) in one or more coronary arteries that have not developed a collateral blood supply⁵. This sudden blockage is primarily due to blood clots (thrombosis) forming on the top of atherosclerotic plaques. The victim did not have a blood clot (thrombosis) identified during the emergency cardiac catheterization or at autopsy.

Fire fighting activities are strenuous and often require fire fighters to work at near maximal heart rates for long periods. The increase in heart rate has been shown to begin with responding to the initial alarm and persist through the course of fire suppression activities⁶⁻⁸. Epidemiologic studies have found that heavy physical exertion sometimes immediately precedes and triggers the onset of acute heart attacks⁹⁻¹². The mental and physical stress of responding to the emergency, briskly walking up two flights of stairs in his bunker gear, and his underlying atherosclerotic coronary artery disease all probably contributed to this victim's heart attack, cardiac arrest, cardiogenic shock, and sudden cardiac death.

This victim did not report prior episodes of angina (heart pain) during physical activity performed on or off the job. But sudden cardiac death is often the first overt manifestation of ischemic heart disease¹³.

There were discrepancies in the frequency and content of the Department's and the Union's negotiated medical evaluation and those recommended by the NFPA¹⁴. For example, the Department conducted extensive pre-employment/pre-placement medical evaluations, including treadmill stress tests on all applicants, regardless of age. The NFPA recommends stress tests for those 35 years

old and above with known CAD risk factors and 40 years old and above for those without CAD risk factors.

The NFPA also recommends annual medical evaluations, with periodic medical examinations. Stress tests are included as part of these medical examinations. It is assumed that if a treadmill test was performed on this fire fighter, his underlying CAD would have been identified and he would have been directed toward further evaluation and treatment¹⁵.

RECOMMENDATIONS AND DISCUSSION

The following recommendations address health and safety generally. This list includes some preventive measures that have been recommended by other agencies to reduce the risk of on-the-job heart attacks and sudden cardiac arrest among fire fighters. These recommendations have not been evaluated by NIOSH but represent research presented in the literature or of consensus votes of Technical Committees of the National Fire Protection Association or labor/management groups within the fire service. In addition, they are presented in a logical programmatic order, and are not listed in a priority manner.

Recommendation #1: Fire Fighters should have annual medical evaluations to determine their medical ability to perform duties without presenting a significant risk to the safety and health of themselves or others.

Guidance regarding the content and scheduling of periodic medical examinations for fire fighters can be found in NFPA 1582, Standard on Medical Requirements for Fire Fighters¹⁴, and in the report of the International Association of Fire Fighters/International Association of Fire Chiefs wellness/fitness initiative¹⁶. The department is not legally required to follow any of these standards.

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Nonetheless, we recommend the City and Union **negotiate** the content and frequency to be consistent with the above guidelines.

Specifically, the pre-employment/pre-placement stress (EKG) tests are not necessary for applicants under the age of 35. Additionally, the lack of medical value of back x-rays had been previously demonstrated and accepted. While these tests are not harmful, they do represent an unnecessary expense for the department. On the other hand, beginning at age 35, annual/periodic medical evaluations should be conducted and should include stress tests for fire fighters with risk factors for CAD.

In addition to providing guidance on the frequency and content of the medical evaluation, NFPA 1582 provides guidance on medical requirements for persons performing fire fighting tasks. Applying NFPA 1582 involves legal issues, so it should be carried out in a **confidential, nondiscriminatory** manner. Appendix D of NFPA 1582 provides guidance for Fire Department Administrators regarding legal considerations in applying the standard.

Applying NFPA 1582 also involves economic issues. These economic concerns go beyond the costs of administering the medical program; they involve the personal and economic costs of dealing with the medical evaluation results. NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses these issues in Chapter 8-7.1 and 8-7.2¹⁷.

The success of medical programs hinges on protecting the affected fire fighter. The department must (1) keep the medical records confidential, (2) provide alternate duty positions for fire fighters in rehabilitation programs, and (3) provide permanent alternate duty positions or other supportive and/or compensated

alternatives if the fire fighter is not medically qualified to return to active fire fighting duties.

Recommendation #2: Reduce risk factors for cardiovascular disease and improve cardiovascular capacity by phasing in a mandatory wellness/fitness program for fire fighters.

NFPA 1500 requires a wellness program that provides health promotion activities for preventing health problems and enhancing overall well-being¹⁷. In 1997, the International Association of Fire Fighters and the International Association of Fire Chiefs joined in a comprehensive Fire Service Joint Labor Management Wellness/Fitness Initiative to improve fire fighter quality of life and maintain physical and mental capabilities of fire fighters. Ten fire departments across the United States joined this effort to pool information about their physical fitness programs and to create a practical fire service program. They produced a manual with a video detailing elements of such a program¹⁶. The Fire Department and the Union should review these materials to identify applicable elements for their department. Other large-city negotiated programs can also be reviewed as potential models.

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INVESTIGATOR INFORMATION

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